



UoSAT-12 IP Test Plan Overview

STRV Steering Group Meeting #2

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UoSAT-12 IP Test Overview



- **Prepare UoSAT-12 and Surrey Ground Station**
- **Execute Initial Tests**
 - Basic network connectivity (PING)
 - Clock synchronization (NTP)
 - File transfer/link utilization (FTP)
 - Blind commanding (UDP packets)
- **Deliver Test Reports**
- **Future Tests**
 - Automatic store-and-forward (SMTP)
 - Multiple ground stations (Mobile IP)
 - Security (VPNs on ground and space links)
 - Constellations (ad-hoc networking, multicast data delivery)



UoSAT-12 & Surrey Ground Station



- **UoSAT-12 Flight Software**
 - SpaceCraft Operating System (SCOS) developed by VyTek
 - VyTek adding BSD 4.4 IP stack to SCOS
 - VyTek adding NTP and FTP servers for SCOS
- **Surrey Satellite Technology Ltd. (SSTL) Ground Station**
 - SSTL will upload new SCOS software to secondary 386 CPU
 - Cisco router with RS-530 interface supplied to SSTL
 - Surrey interfacing router to clock/data from transceiver
 - Surrey will verify router receiving HDLC frames
- **Security**
 - Initial tests will be done with IP access lists in SSTL main router at the ground station
 - Later tests will use VPN between GSFC and Surrey



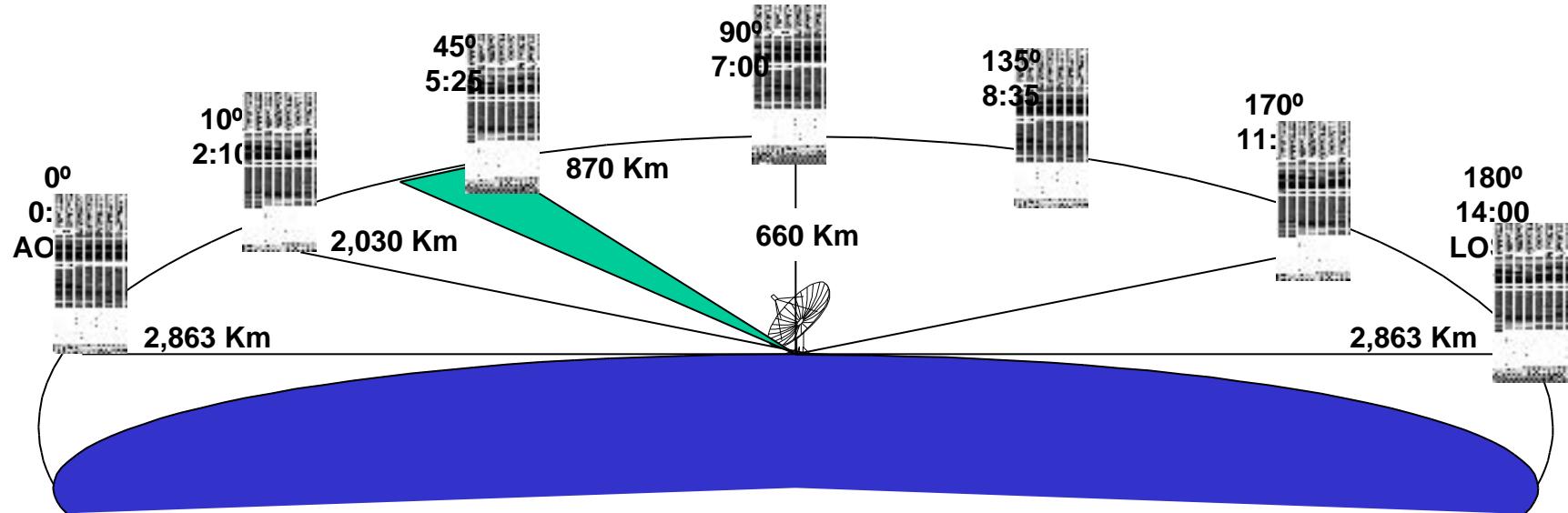
- Propagation Delays

Data Path \ Elevation	0°	10°	45°	90°
One-way delay (ms.)	10	7	3	2
64B packet round-trip (ms.)	76	73	69	68
1280B packet round-trip (ms.)	1,340	1,334	1,326	1,324

Pkt. Size \ Rate	9.6	38.4
64 byte (ms.)	53	13
1280 byte (ms.)	1,060	260

- Total Pass Time - 14:00 on a 90° max. elevation pass

- 9:40 from 10° to 170° 4:20 on outer 10° - 45%





UoSAT-12 Data Transfer Characteristics

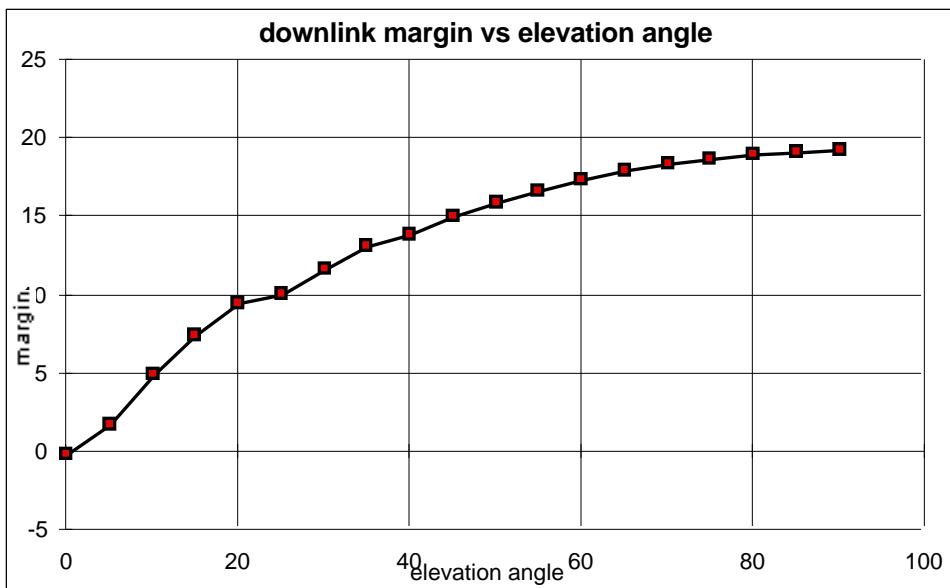
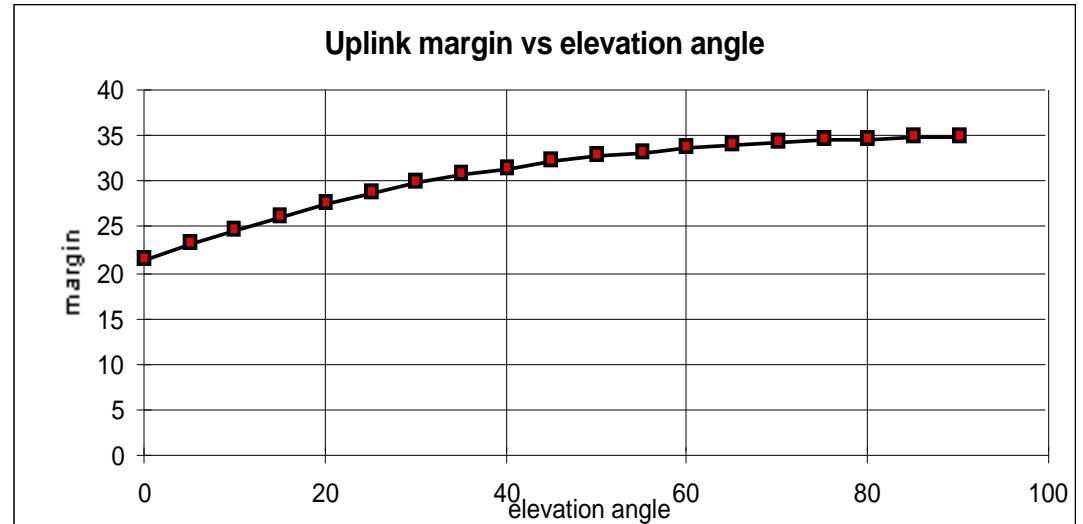


- **Data Rates**
 - Uplink - 9.6 Kbps Downlink - 38.4 Kbps
 - Other rates up to 1 Mbps downlink available
- **Data Volume / Time**
 - Data transfer volumes selected to provide 1 minute or less transfers for most tests
 - Allow up to 14 transfer measurements per pass

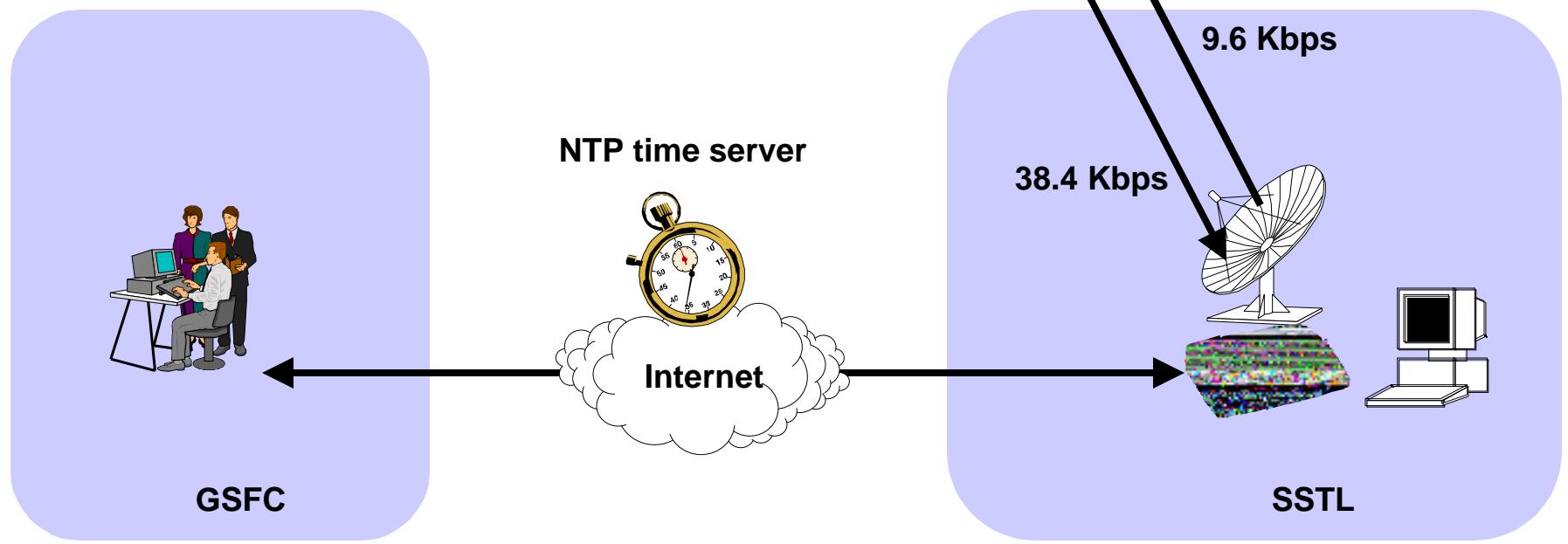
Bits	Bytes	9.6 Kbps	38.4 Kbps
100 K	12.5 K	10.4 sec.	2.6 sec.
1 M	125 K	104 sec.	26 sec.
10 M	1.25 M	17:20	4:20
30 M	3.75 M	52:00	13:00



- **Link margins computed at 0 margin = Eb/No of 12 dB 10e-5 BER**



- Sun workstation at GSFC
- NTP time server at USNO
- Cisco router at Surrey ground station
- FTP workstation at Surrey
- UoSAT-12 spacecraft





Raw Data Collected



- **GSFC**
 - Sun Solaris statistics
 - PINGs from Sun
 - Ethernet packet traces
- **Surrey**
 - Cisco router statistics
 - Logs of lock, elevation/signal strength, time
- **UoSAT-12**
 - Signal strength, transmit power, attitude, voltage, current, temp.
 - IP stack counters
 - NTP and GPS time readouts



GSFC Statistics



- **Unix stats**

- **Unix PING**

```
ipinspace.gsfc.nasa.gov%./GS_ping_script
Mon Mar 20 19:59:40 GMT 2000 : 108 bytes from 150.144.200.71: icmp_seq=0. time=147. ms
Mon Mar 20 19:59:41 GMT 2000 : 108 bytes from 150.144.200.71: icmp_seq=1. time=143. ms
```

- **Solaris IP stack statistics**

				IP	ipForwarding = 2		ipDefaultTTL = 255	
UDP	udpInDatagrams = 67298	udpInErrors = 0	ipInReceives = 25071958				ipInHdrErrors = 3	
	udpOutDatagrams = 7777		ipInAddrErrors = 0				ipInCsumErrs = 0	
			ipForwDatagrams = 0				ipForwProhibits = 0	
			ipInUnknownProtos = 59609				ipInDiscards = 0	
TCP	tcpRtoAlgorithm = 4	tcpRtoMin = 200	ipInDelivers = 21004733				ipOutRequests = 17812467	
	tcpRtoMax = 60000	tcpMaxConn = -1	ipOutDiscards = 0				ipOutNoRoutes = 0	
	tcpActiveOpens = 3610	tcpPassiveOpens = 3699	ipReasmTimeout = 60				ipReasmReqds = 0	
	tcpAttemptFails = 1784	tcpEstabResets = 538	ipReasmOKs = 0				ipReasmFails = 0	
	tcpCurrEstab = 23	tcpOutSegs = 17759236	ipReasmDuplicates = 0				ipReasmPartDups = 0	
	tcpOutDataSegs = 277229	tcpOutDataBytes = 354514836	ipFragOKs = 0				ipFragFails = 0	
	tcpRetransSegs = 4527	tcpRetransBytes = 5489366	ipFragCreates = 0				ipRoutingDiscards = 0	
	tcpOutAck = 17481363	tcpOutAckDelayed = 14196058	tcpInErrs = 4				udpNoPorts = 3898091	
	tcpOutUrg = 0	tcpOutWinUpdate = 101	udpInCsumErrs = 0				udpInOverflows = 0	
	tcpOutWinProbe = 38	tcpOutControl = 16964	rawipInOverflows = 0					
	tcpOutRsts = 4413	tcpOutFastRetrans = 722		ICMP	icmpInMsgs = 2021	icmpInErrors = 0		
	tcpInSegs = 20935059				icmpInCsumErrs = 0	icmpInUnknowns = 0		
	tcpInAckSegs = 154945	tcpInAckBytes = 353614015			icmpInDestUnreachs = 185	icmpInTimeExcds = 178		
	tcpInDupAck = 20126	tcpInAckUnsent = 0			icmpInParmProbs = 0	icmpInSrcQuenches = 0		
	tcpInInorderSegs = 20749219	tcpInInorderBytes = 3437366956			icmpInRedirects = 1	icmpInBadRedirects = 0		
	tcpInUnorderSegs = 6044	tcpInUnorderBytes = 6407320			icmpInEchos = 124	icmpInEchoReps = 1530		
	tcpInDupSegs = 1309	tcpInDupBytes = 632572			icmpInTimestamps = 0	icmpInTimestampReps = 0		
	tcpInPartDupSegs = 2102	tcpInPartDupBytes = 1092066			icmpInAddrMasks = 0	icmpInAddrMaskReps = 0		
	...				icmpInFragNeeded = 0	icmpOutMsgs = 59683		
					icmpOutDrops = 0	icmpOutErrors = 0		
					...			

- **EtherPeek Packet traces**



Surrey Cisco Router Statistics



- **Surrey Cisco stats**

- Show Interface Serial 0 - framing details and bytes in/out

```
omniground#sh in s0
Serial0 is up, line protocol is up
Hardware is QUICC Serial
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec, rely 255/255, load 1/255
Encapsulation FRAME-RELAY IETF, loopback not set, keepalive not set
FR SVC disabled, LAPF state down
Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
Last input 1w2d, output 00:00:01, output hang never
Last clearing of "show interface" counters 2d22h
Queueing strategy: fifo
Output queue 0/40, 0 drops; input queue 0/75, 0 drops
5 minute input rate 90000 bits/sec, 13 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
    2490448 packets input, 1770245790 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    852 packets output, 25560 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions
    DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

- Show IP traffic - IP packets and CRC status
 - Show NTP - router NTP sync status

- **Surrey ground station statistics**

- Receiver lock, elevation/signal strength, time

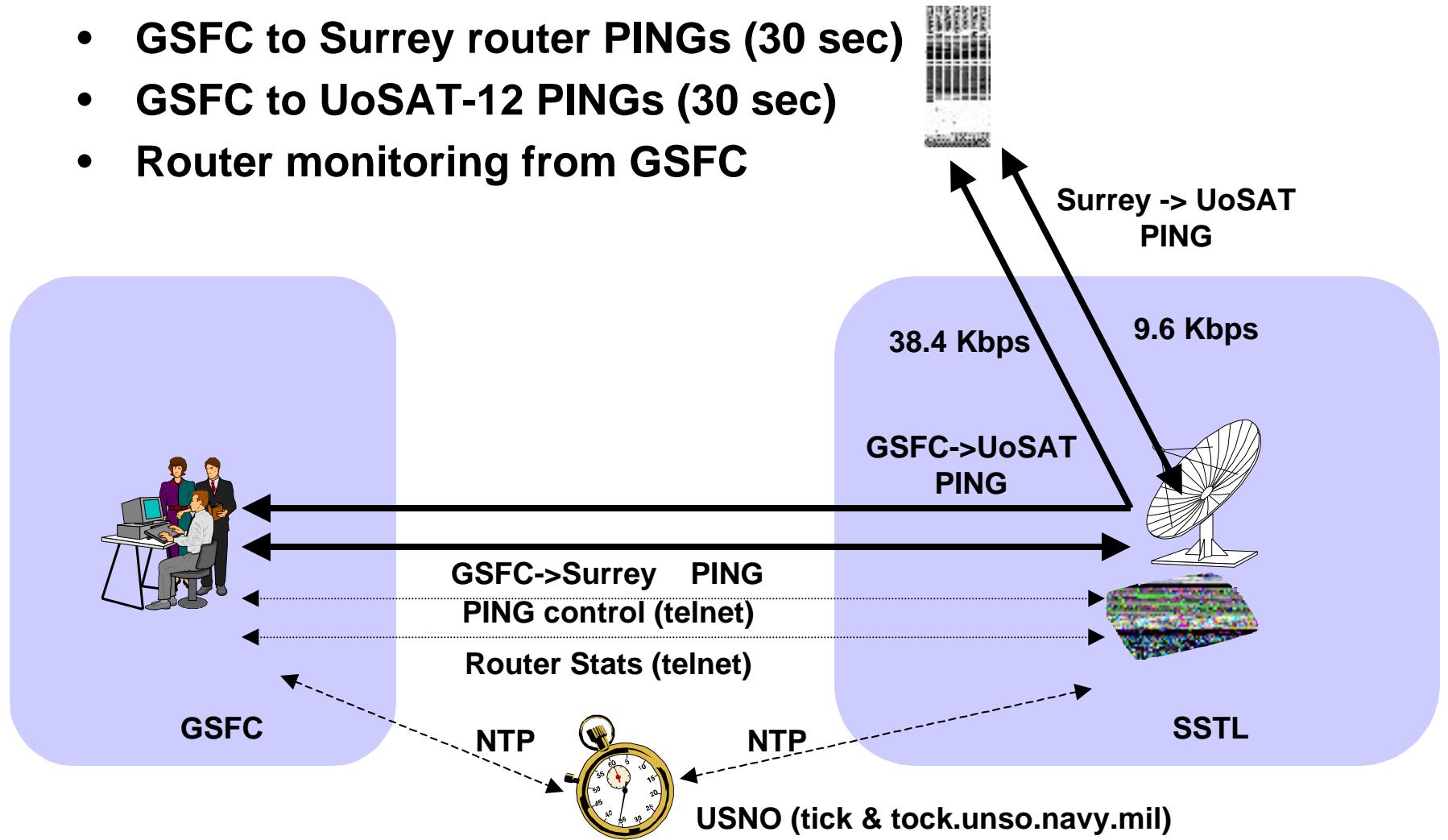


- **UoSAT-12 internal statistics**

- Receive signal strength
- Transmit power
- Attitude
- Voltages, currents, temperatures
- Possibly GPS time
- IP stack statistics



- Continual PING from router to UoSAT-12
- GSFC to Surrey router PINGs (30 sec)
- GSFC to UoSAT-12 PINGs (30 sec)
- Router monitoring from GSFC





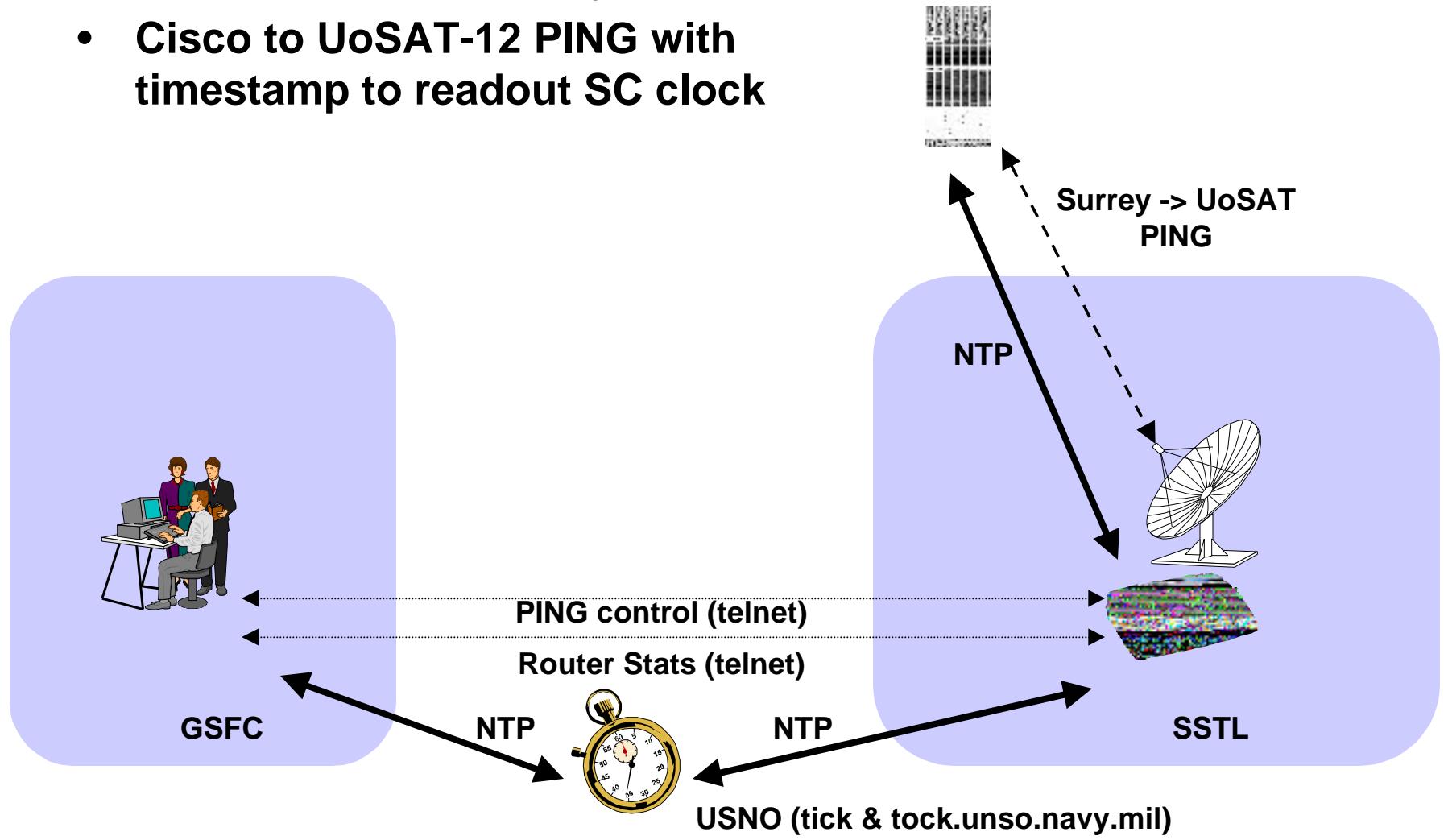
Network Connectivity Tests



- **PING Tests**
 - Verify HDLC/Frame Relay framing functionality
 - Demonstrate end-to-end network connectivity
 - Measure propagation delay from AOS to LOS
 - Simple link availability from AOS to LOS
- **Data collected**
 - Continual PINGs from Surrey to UoSAT-12
 - Detailed characterization of delay/connectivity from AOS to LOS
 - 30 second PINGs from GSFC to Surrey router
 - Characterize ground Internet performance
 - 30 second PINGs from GSFC to UoSAT-12
 - Demonstrate and measure end-to-end connectivity performance
 - Surrey router statistics
 - Monitor serial link data transfers and errors



- NTP on UoSAT-12 to sync SC clock
- Cisco to UoSAT-12 PING with timestamp to readout SC clock





Clock Sync Tests



- **NTP Test Configuration**

- Sync Surrey router with USNO NTP server
- Set Surrey router to be NTP server
- Install NTP daemon on UoSAT-12

- **NTP Tests**

- Use PING with timestamp to read and compare SC clock

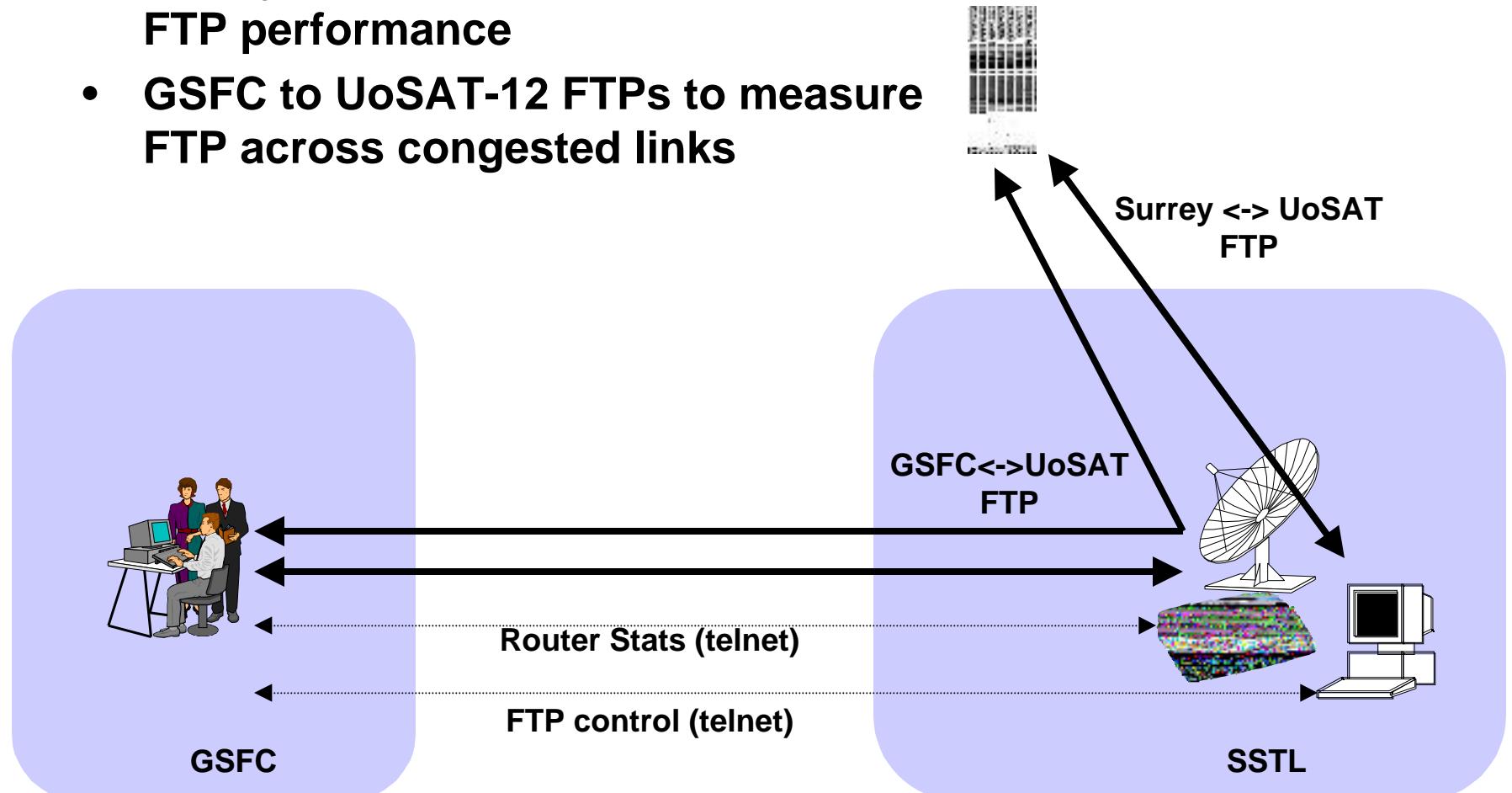
```
Type escape sequence to abort.  
Sending 5, 64-byte ICMP Echos to 150.144.200.71, timeout is 2 seconds:  
Packet has IP options: Total option bytes= 16, padded length=16  
Timestamp: Type 0. Overflows: 0 length 16, ptr 5  
>>Current pointer<<  
Time= 00:00:00.000 UTC (00000000)  
Time= 00:00:00.000 UTC (00000000)  
Time= 00:00:00.000 UTC (00000000)
```

```
Reply to request 0 (4 ms). Received packet has options  
Total option bytes= 16, padded length=16  
Timestamp: Type 0. Overflows: 0 length 16, ptr 17  
Time= 20:37:29.431 UTC (046CF4D7)  
Time= 20:37:29.035 UTC (046CF34B)  
Time= 20:37:29.435 UTC (046CF4DB)  
>>Current pointer<<
```

- Possibly compare SC clock with onboard GPS time



- Surrey to UoSAT-12 FTPs to measure FTP performance
- GSFC to UoSAT-12 FTPs to measure FTP across congested links





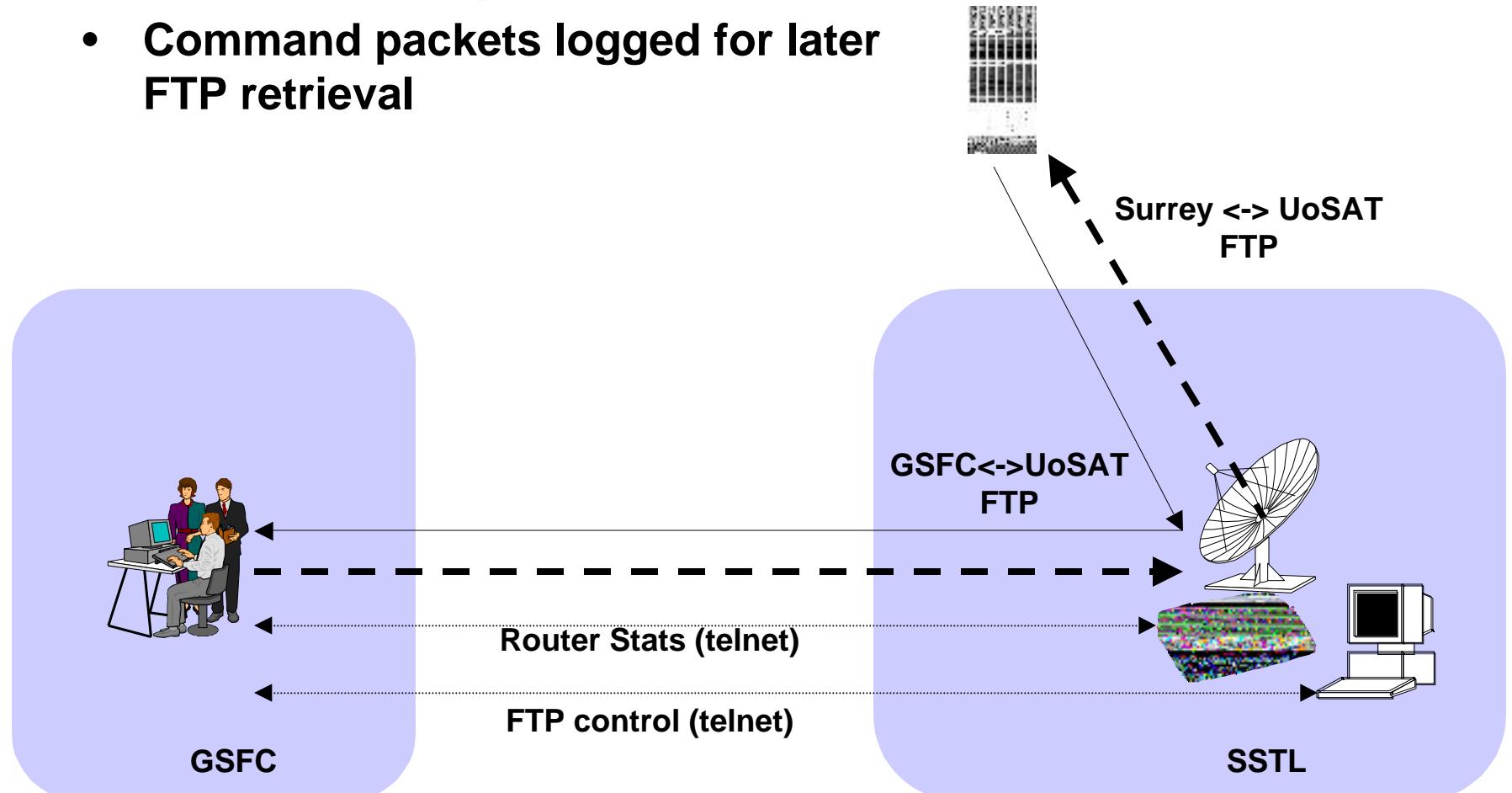
File Transfer / Link Performance



- **FTP Test Configuration**
 - Activate FTP server on UoSAT-12
 - Prepare test files of 12.5 KB and 125 KB
- **FTP Tests**
 - Periodic upload of 12.5 KB file on 9.6 Kbps uplink
 - Periodic download of 125 KB file on 38.4 Kbps downlink
 - Measure transfer rates for same file from AOS to LOS
 - Compute link utilization



- UDP command packets to UoSAT-12
- Command packets logged for later FTP retrieval





Blind Commanding Tests



- **Blind Commanding Test Configuration**
 - Blind command logger process on UoSAT-12
 - Blind command application on ground systems at GSFC and SSTL
- **Blind Commanding Tests**
 - Send sequence numbered commands in UDP packets from SSTL
 - Send sequence numbered commands in UDP packets from GSFC
 - Blind commands logged to onboard file
 - File retrieved later using FTP
 - Command file analyzed for loss